US007972195B2

(12) **United States Patent**
Ogawa

(10) **Patent No.: US 7,972,195 B2**
(45) **Date of Patent: Jul. 5, 2011**

(54) **TIRE GRINDING METHOD AND GRINDING DEVICE**

(75) Inventor: **Yuichiro Ogawa**, Kodaira (JP)

(73) Assignee: **Bridgestone Corporation**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 513 days.

(21) Appl. No.: **12/090,788**

(22) PCT Filed: **Oct. 18, 2006**

(86) PCT No.: **PCT/JP2006/320721**
§ 371 (c)(1), (2), (4) Date: **May 29, 2008**

(87) PCT Pub. No.: **WO2007/046404**
PCT Pub. Date: **Apr. 26, 2007**

(65) **Prior Publication Data**

US 2009/0291618 A1 Nov. 26, 2009

(30) **Foreign Application Priority Data**

Oct. 18, 2005 (JP) 2005-303118

(51) **Int. Cl.**
B24B 49/00 (2006.01)

(52) **U.S. Cl.** **451/8**; 451/49

(58) **Field of Classification Search** 451/8, 5, 451/49, 143, 146
See application file for complete search history.

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Primary Examiner — Robert Rose
(74) *Attorney, Agent, or Firm* — Sughrue Mion, PLLC

(57) **ABSTRACT**

In a grinding device, first, an eddy-current-sensor detects a distance from the eddy-current-sensor to an outer peripheral surface of a belt layer while a tire to be retreaded held by a pair of half rims is caused to rotate. Thus, an eccentricity amount and an eccentricity direction of the tire to be retreaded with respect to a device axial center, corresponding to the phase of the tire to be retreaded, can be respectively determined, so position control signals corresponding to the phase, eccentricity amount and eccentricity direction of the tire to be retreaded can be generated. Next, on the basis of the position control signal, a carriage causes a rasp to be moved in a radial direction with respect to the tire to be retreaded along the radial direction whose center is a device axial center, and the rasp grinds a tread surface of the rotating tire to be retreaded.

3 Claims, 3 Drawing Sheets

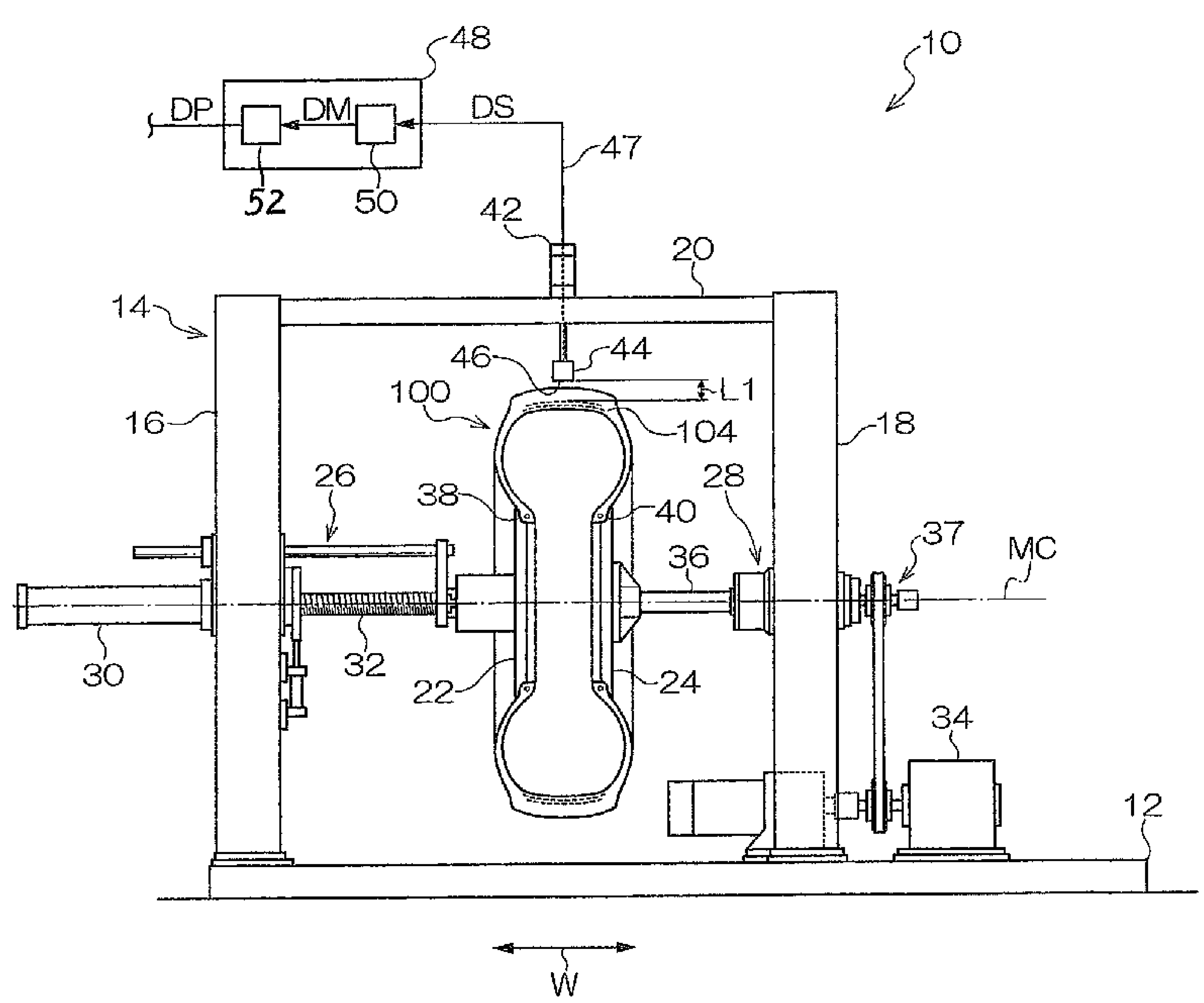

FIG. 1

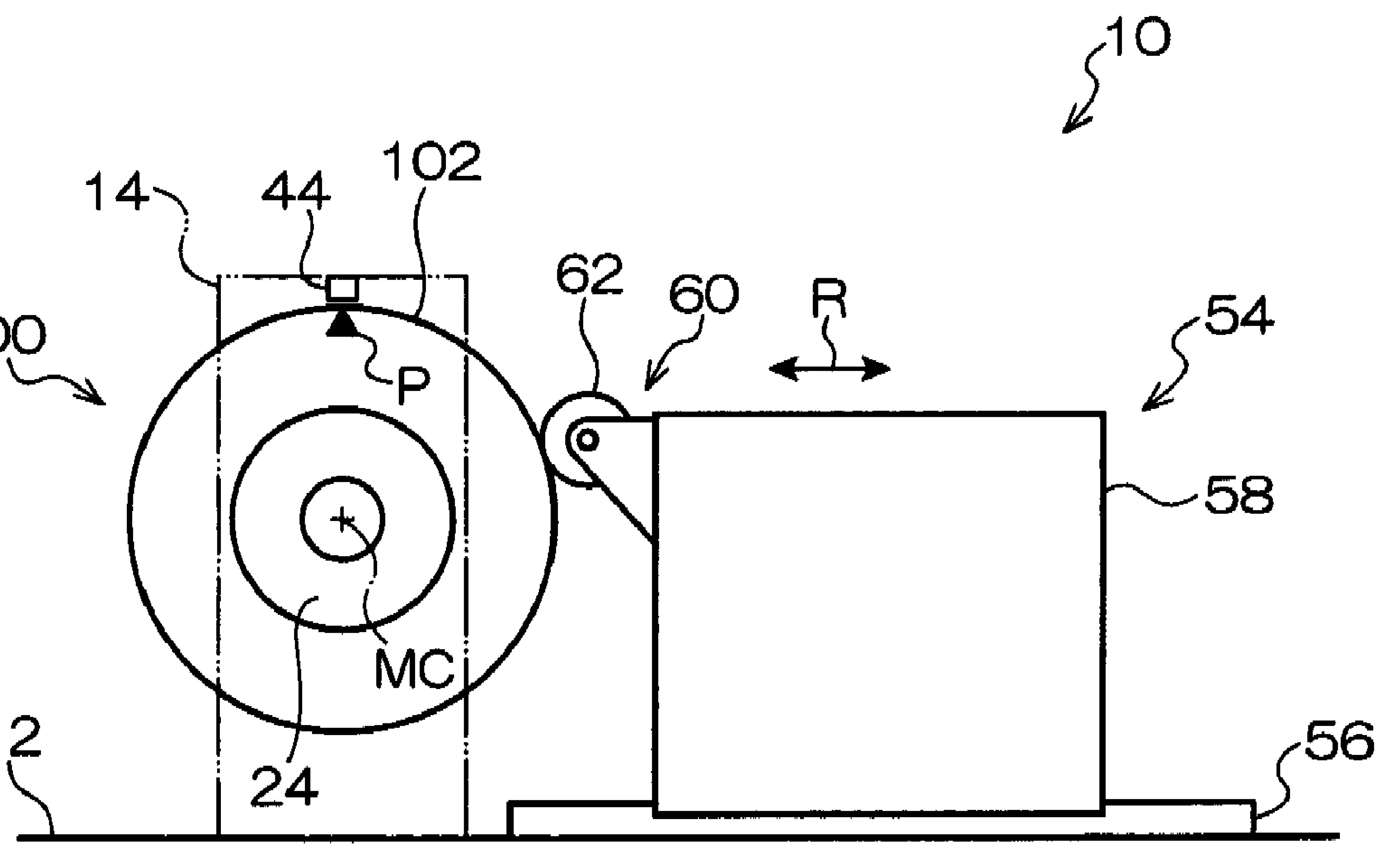

FIG. 2

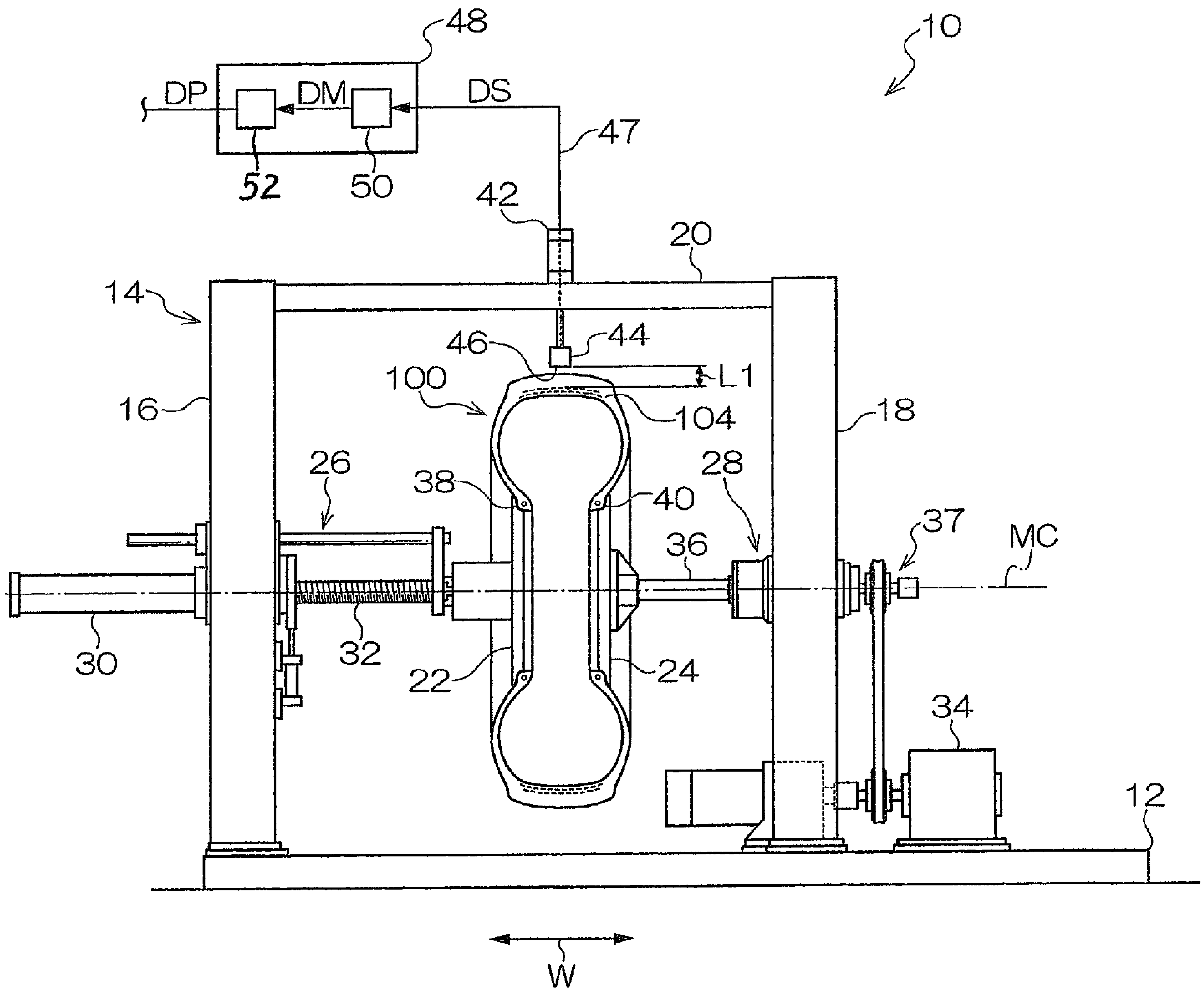
48
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FIG. 3A

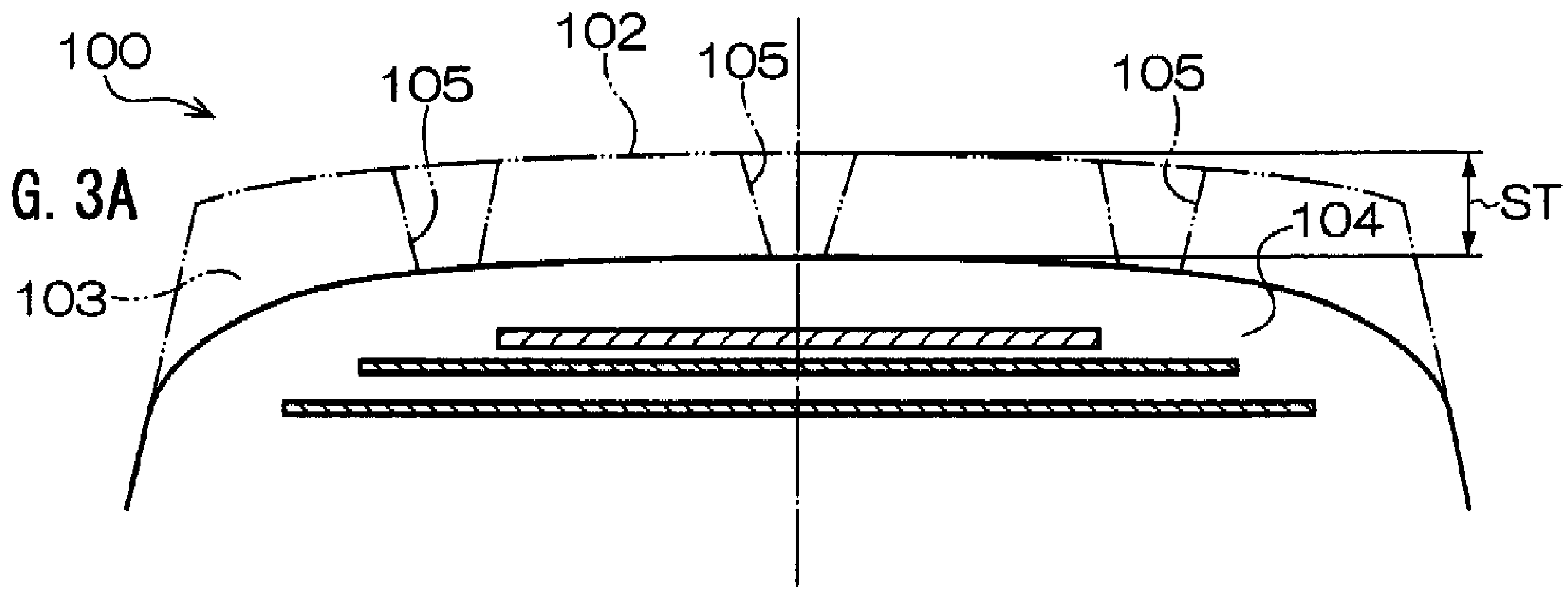


FIG. 3B

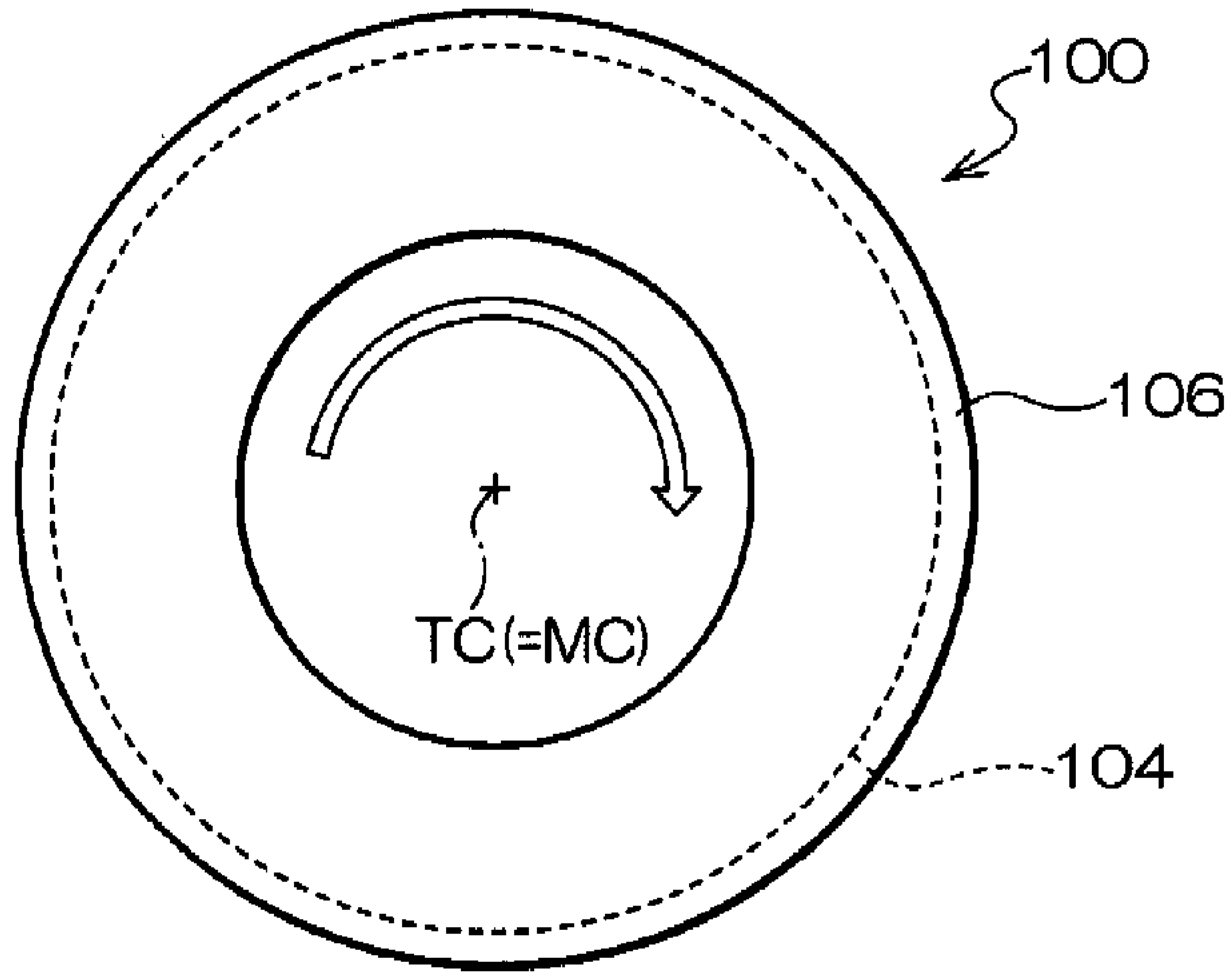
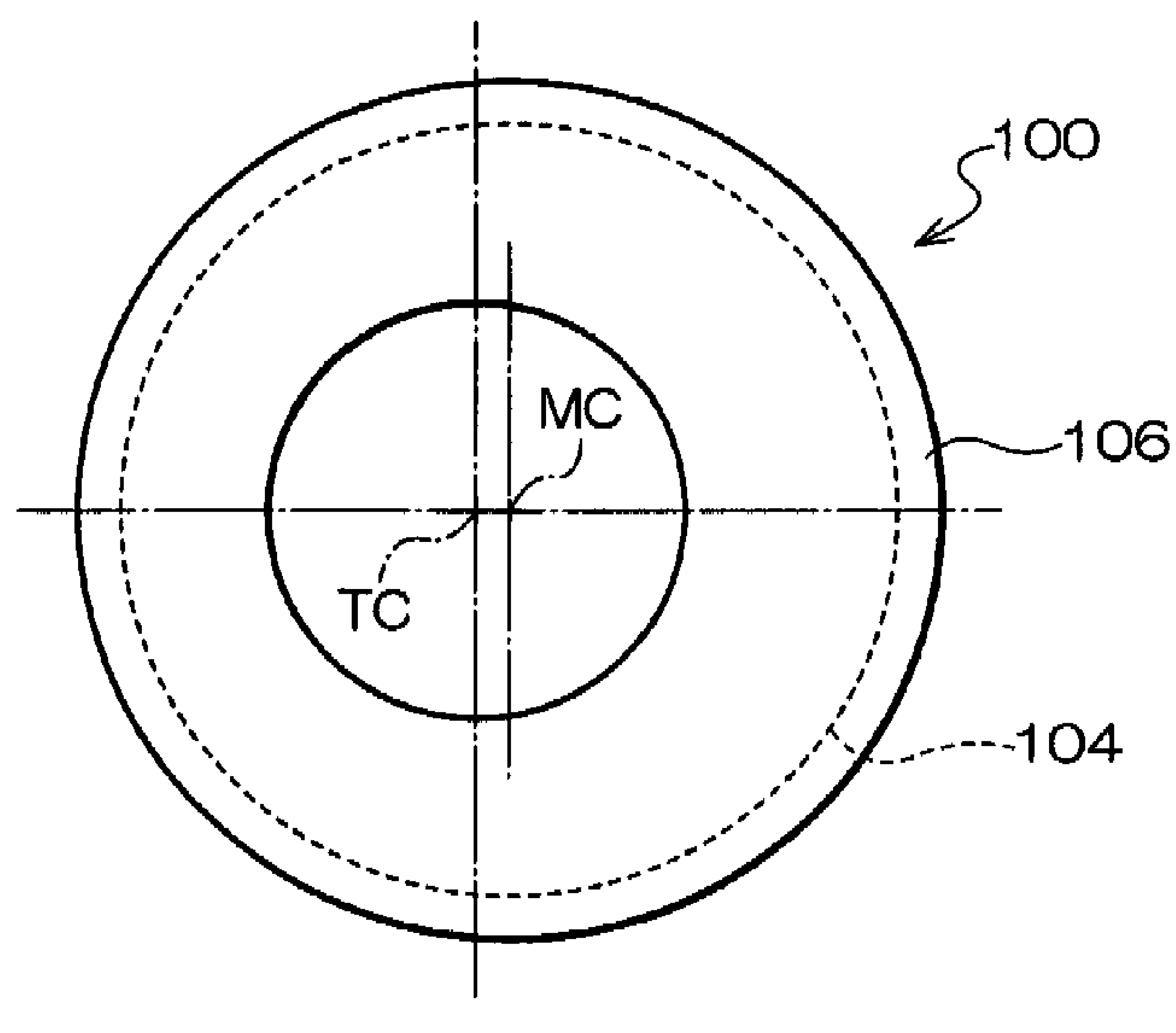


FIG. 3C



TIRE GRINDING METHOD AND GRINDING DEVICE

BACKGROUND

1. Field of Invention

The present invention relates to a tire grinding method and grinding device that grind a tread portion of a tire to be retreaded in order to retread a worn tire to be retreaded.

2. Related Art

Techniques for retreading retreadable tires may be broadly classified into mold vulcanization (hot retreading), which uses a tire mold (die), and precure retreading (cold retreading), which does not use a mold but attaches a patterned tread that has already been vulcanized to a base tire and vulcanizes this in a vulcanization can. In either technique, as for the tire to be retreaded (base tire) that is supplied to retreading, first, the tread portion is cut and formed into a required shape in a buffing step, but in regard to the buffed tire after implementation of this buffing, the thickness from the embedded belt layer to the outer peripheral surface (old rubber thickness) becomes an important factor that determines the performance of the retreaded tire (particularly exothermic durability).

In Patent Document 1, there is disclosed a grinding device that can automatically control the grinding amount with respect to the base tire such that the above mentioned old rubber thickness of the base tire after grinding becomes an optimum value that has been set beforehand. In the grinding device of Patent Document 1, Japanese Patent Application Laid-Open No. 58-1546, a tire to be retreaded that is rotatably held by a holding mechanism is caused to rotate, the belt layer of the tire to be retreaded is detected by a metal sensor to measure the old rubber thickness of the tire to be retreaded, the outer peripheral surface of the tire to be retreaded is grinded by a grinding mechanism, and cutting and grinding of the tire to be retreaded by the grinding mechanism is stopped at a timing when the old rubber thickness of the tire to be retreaded becomes the optimum value.

However, in the grinding device of Patent Document 1, when the tire to be retreaded is rotated about a central axis (device axial center) of the holding mechanism and the outer peripheral surface of the tire to be retreaded is grinded by the grinding mechanism, when the device axial center and the central axis of the tire to be retreaded (tire axial center) coincide, the tire to be retreaded can be grinded such that the old rubber thickness becomes constant (the optimum value) at an arbitrary site along the tire rotational direction. However, when the device axial center and the central axis of the tire to be retreaded (tire axial center) do not coincide, the old rubber thickness along the tire rotational direction of the tire to be retreaded after grinding does not become constant, and deviation corresponding to the eccentricity amount of the tire to be retreaded arises in the old rubber thickness. For this reason, when the device axial center and the tire axial center do not coincide due to eccentricity or deformation of the tire to be retreaded, the old rubber thickness of the tire to be retreaded after grinding becomes nonuniform, performance such as durability of a retreaded tire that has been manufactured from the tire to be retreaded drops, or the old rubber thickness of the tire to be retreaded after grinding locally disappears and the belt layer becomes exposed, and there is potential to become unable to manufacture a retreaded tire from this tire to be retreaded.

In consideration of the above-described circumstances, it is an object of the present invention to provide a tire grinding method and grinding device that can grind a tire to be retreaded by grinding means such that the thickness of residual rubber on an outer peripheral side of a belt layer of the tire to be retreaded becomes constant even when eccentricity arises in the tire to be retreaded.

In order to achieve this object, a tire grinding method pertaining to a first aspect of the present invention includes: when a tire to be retreaded is loaded into a holding mechanism of a grinding device and a tread portion of the tire to be retreaded that is rotated by the holding mechanism about a device axial center is to be grinded by grinding means, detecting, with a metal detection sensor along a rotating direction whose center is the device axial center, a distance from the device axial center to a metal belt layer of the tire to be retreaded that is held by the holding mechanism, and thereafter causing the grinding means to relatively move with respect to the tire to be retreaded along a radial direction whose center is the device axial center on the basis of a position along a rotating direction of the tire to be retreaded and the detected value of the distance from the device axial center to the belt layer, and grinding, with the grinding means, the tread portion of the tire to be retreaded that is rotated by the holding mechanism.

In the tire grinding method pertaining to a first aspect, first, the distance from the device axial center to the metal belt layer of the tire to be retreaded that is rotated by the holding mechanism is detected by the metal detection sensor along the tire rotating direction, whereby the distance from the device axial center to the belt layer that corresponds to the position (phase) along the rotating direction of the tire to be retreaded can be determined as a detected value by a detection signal from the metal detection sensor, so the eccentricity amount and the eccentricity direction of the tire to be retreaded with respect to the device axial center, corresponding to the phase of the tire to be retreaded, can be respectively determined on the basis of this detected value.

In the tire grinding method pertaining to a first aspect, next, the grinding means is caused to relatively move with respect to the tire to be retreaded along the radial direction whose center is the device axial center on the basis of the phase of the tire to be retreaded and the eccentricity amount and eccentricity direction of the tire to be retreaded that have been determined as described above, and the tread portion of the tire to be retreaded that is rotated by the holding mechanism is grinded by the grinding means, whereby the tire to be retreaded can be grinded by the grinding means such that the thickness of residual rubber on the outer peripheral side of the belt layer of the tire to be retreaded becomes constant even if eccentricity with respect to the device axial center arises in the tire to be retreaded.

Further, in a tire grinding method pertaining to a second aspect in the tire grinding method of a first aspect, when the tire to be retreaded is grinded by the grinding means, the grinding means is relatively moved along the radial direction, such that a distance from a center of curvature of the belt layer of the tire to be retreaded to the grinding means becomes constant, on the basis of the position along the rotating direction of the tire to be retreaded and the detected value of the distance from the device axial center to the belt layer that has been detected by the metal detection sensor.

Further, in a tire grinding method pertaining to a third aspect in the tire grinding method of a first or second aspect, before the distance from the device axial center to the metal belt layer of the tire to be retreaded that is held by the holding mechanism is detected by the metal detection sensor along the tire rotating direction, the tread portion is grinded until groove portions substantially disappear from a tread surface of the tire to be retreaded.

A tire grinding device pertaining to a fourth aspect of the present invention includes: a holding mechanism that rotatably holds a tire to be retreaded about a device axial center and causes the tire to be retreaded to rotate about the device axial center; grinding means that contacts a tread portion of the tire to be retreaded that is rotated by the holding mechanism and grinds the tread portion; a metal detection sensor that detects, along a rotating direction whose center is the device axial center, a distance from the device axial center to a metal belt layer of the tire to be retreaded that is held by the holding mechanism; and grinding position adjusting means that causes, when the tire to be retreaded is grinded by the grinding means, the grinding means to relatively move with respect to the tire to be retreaded along a radial direction whose center is the device axial center on the basis of a position along a rotating direction of the tire to be retreaded and the detected value of the distance from the device axial center to the belt layer.

In the tire grinding device pertaining to a fourth aspect, first, the distance from the device axial center to the metal belt layer of the tire to be retreaded that is held by the holding mechanism is detected by the metal detection sensor along the tire rotating direction, whereby the distance from the device axial center to the belt layer that corresponds to the position (phase) along the rotating direction of the tire to be retreaded can be determined as a detected value by a detection signal of the metal detection sensor, so the eccentricity amount and the eccentricity direction of the tire to be retreaded with respect to the device axial center that correspond to the phase of the tire to be retreaded can be respectively determined on the basis of this detected value.

In the tire grinding device pertaining to a fourth aspect, next, the grinding means is caused to relatively move with respect to the tire to be retreaded along the radial direction whose center is the device axial center on the basis of the phase of the tire to be retreaded and the eccentricity amount and eccentricity direction of the tire to be retreaded that have been determined as described above, and the tread portion of the tire to be retreaded that is rotated by the holding mechanism is grinded by the grinding means, whereby the tire to be retreaded can be grinded by the grinding means such that the thickness of residual rubber on the outer peripheral side of the belt layer of the tire to be retreaded becomes constant even when eccentricity with respect to the device axial center arises in the tire to be retreaded.

Further, in a tire grinding device of a fifth aspect in the tire grinding device of a fourth aspect, the grinding position adjusting means causes, when the tire to be retreaded is grinded by the grinding means, the grinding means to relatively move with respect to the tire to be retreaded along the radial direction, such that a distance from a center of curvature of the belt layer to the grinding means becomes constant, on the basis of the position along the rotating direction of the tire to be retreaded and the detected value of the distance from the device axial center to the belt layer that has been detected by the metal detection sensor.

As described above, according to the tire grinding method and grinding device pertaining to the present invention, a tire to be retreaded can be grinded by grinding means such that the thickness of residual rubber on an outer peripheral side of a belt layer of the tire to be retreaded becomes constant even when eccentricity with respect to a device axial center arises in the tire to be retreaded.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** A side view showing a tire grinding device pertaining to an embodiment of the present invention.

FIG. **2** A front view showing the configuration of a support frame in the grinding device shown in FIG. **1**.

FIG. **3**A A cross-sectional view, along a radial direction, of a tire to be retreaded that is grinded by the grinding device shown in FIG. **1**.

FIG. **3**B A side view of the tire to be retreaded that is grinded by the grinding device shown in FIG. **1**.

FIG. **3**C A side view of the tire to be retreaded that is grinded by the grinding device shown in FIG. **1**.

DETAILED DESCRIPTION OF THE INVENTION

Below, a tire grinding device and grinding method pertaining to an embodiment of the present invention will be described with reference to the drawings.

Configuration of the Present Embodiment

In FIG. **1** and FIG. **2**, there is shown a tire grinding device pertaining to the embodiment of the present invention. This tire grinding device (below, simply called "grinding device") **10** is, as shown in FIG. **2**, provided with a base **12** that is installed on a floor and a gatepost-like support frame **14** that is installed on this base **12**. Provided on the support frame **14** are a pair of side plate portions **16** and **18** that are arranged so as to face each other along a width direction of the device (direction of arrow W) and a top plate portion **20** that bridges the upper end portions of the pair of side plate portions **16** and **18**. In the support frame **14**, a reciprocating mechanism **26** is disposed on the one side plate portion **16**, and a rotating mechanism **28** is disposed on the other side plate portion **18**.

In the grinding device **10**, a pair of half rims **22** and **24** formed in disc shapes are disposed on the inner sides of the side plate portions **16** and **18**, and these half rims **22** and **24** are supported by the reciprocating mechanism **26** and the rotating mechanism **28**, respectively. The reciprocating mechanism **26** is provided with a linear actuator **30**, and the half rim **22** is coaxially and rotatably coupled to the distal end portion of a support rod **32** that is driven in the width direction by this linear actuator **30**. Further, the rotating mechanism **28** is provided with a drive shaft **36** that is disposed coaxially with the support rod **32** and to which torque from a drive motor **34** is transmitted via a torque transmitting component **37** having a belt, a pulley and the like, and the half rim **24** is coaxially and rotatably coupled to the distal end portion of this drive shaft **36**.

In the grinding device **10**, after the half rim **24** has been attached to one bead portion **40** of a tire to be retreaded **100**, the half rim **22** whose position has been adjusted in the width direction by the linear actuator **30** is attached to another bead portion **38** of the tire to be retreaded **100**. Thus, a space sealed from the outside is formed in the tire to be retreaded **100**, and the tire to be retreaded **100** is expanded as a result of that sealed space being filled with compressed air that has been adjusted to a predetermined pressure.

In the grinding device **10**, an eddy current sensor **44** that is a non-contact type metal detection sensor is disposed via a position adjusting mechanism **42** on the undersurface side of the top plate portion **20**. The position adjusting mechanism **42** supports the eddy current sensor **44** such that the position adjusting mechanism **42** is capable of adjusting the position of the eddy current sensor **44** along an axial direction along a device axial center MC that becomes the rotational center of the half rims **22** and **24** and a radial direction that is orthogonal to this device axial center MC. In the grinding device **10**, the position of the eddy current sensor **44** is adjusted by the position adjusting mechanism **42** along the radial direction and the width direction such that a predetermined clearance is provided to a width direction center of a tread surface **102** that is the outer peripheral surface of the tire to be retreaded **100**. Further, the grinding device **10** is provided with a control circuit **48** for controlling operation of the entire device, the eddy current sensor **44** is connected via a wire **47** to this control circuit **48**, and a detection signal DS that the eddy current sensor **44** outputs is inputted to this control circuit **48**.

Here, the lower end surface of the eddy current sensor **44** is configured as a detection reference surface **46**, and the eddy current sensor **44** outputs, to the control circuit **48**, a detection signal corresponding to a distance L**1** from this detection reference surface **46** to the outer peripheral surface of a steel belt layer **104** in the tire to be retreaded **100**. The control circuit **48** is provided with a data storing component **50** and a calculating component **52**.

As shown in FIG. **1**, the grinding device **10** is provided with a grinding drive mechanism **54** for grinding a tread portion **103** of the tire to be retreaded **100**. Disposed in the grinding drive mechanism **54** are a guide rail **56** that is fixed on the base **12** so as to extend in the radial direction and a carriage **58** that is placed on this guide rail **56** and configured to be movable in the radial direction (direction of arrow R) whose center is the device axial center MC. A grinding tool **60** for the tire to be retreaded **100** is mounted on the carriage **58**, and this grinding tool **60** is provided with a rasp **62** that is a whetstone formed in a circular cylinder shape and a drive component (not shown in the drawings) having a motor and the like for causing this rasp **62** to rotate at a high speed. Further, a position adjusting mechanism for adjusting the position of the rasp **62** in the axial direction of the device (=axial direction of the tire) is disposed in the grinding tool **60** as needed.

The grinding tool **60** causes the outer peripheral surface of the rasp **62** to contact the tread surface **102** of the tire to be retreaded that rotates in one direction and causes the rasp **62** to rotate at a high speed in a following direction or a reverse direction with respect to the tire to be retreaded **100**, whereby the grinding tool **60** grinds (cuts and polishes) the tread surface **102** of the tire to be retreaded **100**.

Operation of the Present Embodiment

The operation of the grinding device **10** pertaining to the present embodiment that is configured as described above and a method of grinding the tire to be retreaded **100** that is implemented by this grinding device **10** will be described.

In the grinding device **10**, when a measurement start command is inputted from an operation component (not shown in the drawings), the tire to be retreaded **100** is caused to rotate in one direction by the rotating mechanism **28**, and the detection signal DS outputted from the eddy current sensor **44** starts to be stored in the data storing component **50** at a timing when a predetermined reference phase point P (see FIG. **1**) in the rotational direction of the tire to be retreaded **100** reaches a detection position of the eddy current sensor **44**, and storage of the detection signal DS from the eddy current sensor **44** by the data storing component **50** is completed at a timing when the reference phase point P of the tire to be retreaded **100** again reaches the detection position of the eddy current sensor **44**. Thus, the detection signals DS corresponding to one rotation of the tire to be retreaded **100** are stored in the data storing component **50** as measurement data DM with respect to the belt layer **104**.

When the measurement data DM is stored in the data storing component **50**, the control circuit **48** outputs this measurement data DM to the calculating component **52**. On the basis of the measurement data DM, the calculating component **52** generates, for every predetermined control pitch, position control signals DP corresponding to one rotation of the tire to be retreaded **100**, that is, a range from the reference phase point P (0°) to 360°.

Next, when a grinding start command is inputted from the operation component, the control circuit **48** causes the carriage **58** that had been in a standby position away from the tire to be retreaded **100** to move towards the tire to be retreaded **100** along the guide rail **56**, causes the rasp **62** of the grinding drive mechanism **54** to rotate at a high speed, and causes this rasp **62** to contact the tread surface **102** of the tire to be retreaded **100**.

At this time, the control circuit **48** causes the carriage **58** to move forward and backward along the guide rail **56** on the basis of the position control signal DP, to thereby causes the rasp **62** to move along the radial direction to a position corresponding to the position control signal DP. Specifically, the control circuit **48** causes, on the basis of the position control signal DP, the carriage **58** to move along the radial direction with respect to the tire to be retreaded **100** such that a distance R from a tire axial center TC (see FIG. **3**A and FIG. **3**B) that is a radius of curvature center point of the belt layer **104** to the rasp **62** becomes constant. However, because the distance R itself becomes smaller by a distance that is equal to a later-described grinding amount ST from the point in time when grinding starts to the point in time when grinding ends, the control circuit **48** uses, as a control period, a period when the tire to be retreaded **100** completes one rotation from the reference phase point P, and the control circuit **48** maintains the distance R at a constant during this control period.

Further, when the rasp **62** contacts the tread surface **102**, the control circuit **48** sets this position as a grinding start position of the rasp **62** and sets a grinding end position of the rasp **62** in accordance with the necessary grinding amount ST (see FIG. **3**A) with respect to the tire to be retreaded **100**. Here, the grinding end position of the rasp **62** becomes a position on the inner peripheral side a distance that is equal to the grinding amount ST with respect to the grinding start position along the radial direction whose center is the tire axial center TC. The control circuit **48** causes the rasp **62** to move at a predetermined grinding speed from the grinding start position to the grinding end position. Thus, the tread portion **103** of the tire to be retreaded **100** is grinded by the rasp **62**, and the tread portion **103** remaining on the outer peripheral side of the belt layer **104** is removed from the outer peripheral side.

In the grinding device **10** described above, first, the tire to be retreaded that is held by the pair of half rims **22** and **24** is caused to rotate, and the distance L**1** from the detection reference surface **46** to the outer peripheral surface of the belt layer **104** is detected by the eddy current sensor **44**, whereby, on the basis of this distance L**1** and a device constant (distance from the detection reference surface **46** to the device axial center MC), the measurement data DM corresponding to the distance from the device axial center MC to the outer peripheral surface of the belt layer **104** that corresponds to a phase whose reference is the reference phase point P of the tire to be retreaded **100** can be obtained, so the eccentricity amount and the eccentricity direction of the tire to be retreaded **100** with respect to the device axial center that correspond to the phase of the tire to be retreaded can be respectively determined on the basis of this measurement data DM, and the control signal DP corresponding to the phase, eccentricity amount and eccentricity direction of the tire to be retreaded **100** can be generated by the calculating component **52**.

Next, in the grinding device **10**, on the basis of the position control signal DP that has been determined as described above, by the carriage **58**, the rasp **62** is moved with respect to the tire to be retreaded **100** along the radial direction whose center is the device axial center MC, and the rasp **62** grinds the tread surface **102** of the tire to be retreaded **100** that is rotated by the rotating mechanism **28**. At this time, the control circuit **48** causes the carriage **58** to move along the radial direction, such that the distance R from the tire axial center TC to the rasp **62** becomes constant, on the basis of the position control signal DP corresponding to the eccentricity amount and the eccentricity direction with respect to the device axial center MC corresponding to the phase of the tire to be retreaded **100**.

As a result, as shown in FIG. **3**C, even if eccentricity with respect to the device axial center MC arises in the tire axial center TC of the tire to be retreaded **100**, the tire to be retreaded **100** can be grinded by the rasp **62** of the grinding drive mechanism **54** such that the thickness of residual rubber **106** on the outer peripheral side of the belt layer **104** of the tire to be retreaded **100** becomes substantially constant.

Further, as shown in FIG. **3**B, when eccentricity is not arisen in the tire axial center TC of the tire to be retreaded **100**, the eccentricity amount at an arbitrary phase in the tire rotational direction becomes 0, so the control circuit **48** causes the rasp **62** to move at the predetermined grinding speed from the grinding start position to the grinding end position. Thus, the grinding amount at an arbitrary position along the tire rotational direction of the tire to be retreaded **100** becomes constant, and the thickness of the residual rubber **106** remaining on the outer peripheral side of the belt layer **104** also becomes substantially constant after the completion of the grinding of the tire to be retreaded **100**.

It will be noted that, in the grinding device **10** pertaining to the present embodiment, the distance L1 from the detection reference surface **46** to the outer peripheral surface of the belt layer **104** is detected by the eddy current sensor **44** while the tire to be retreaded **100** is rotated in one direction by the rotating mechanism **28** in a state where groove portions **105** (see FIG. **3**A) remain in the tread surface **102** of the tire to be retreaded **100**. However, when the groove portions **105** remain in the tread surface **102**, there is the potential for the detection precision of the eddy current sensor **44** with respect to the belt layer **104** to drop because of the affect of these groove portions **105**. In order to avoid such a drop in detection precision resulting from the affect of the groove portions **105**, the invention may also be configured such that, until the groove portions **105** disappear, the tread portion **103** of the tire to be retreaded **100** is roughly grinded by a grinding tool that is rougher than the rasp **62** and thereafter the tire to be retreaded **100** is grinded by the already mentioned grinding method.

Further, in the grinding device **10**, the rasp **62** is caused to move in the radial direction on the basis of the position control signal DP when the tire to be retreaded **100** is to be grinded, but even when the invention is configured such that the tire to be retreaded **100** is moved along the above-described radial direction on the basis of the position control signal DP in a state where the rasp **62** is fixed, the thickness of the residual rubber **106** remaining on the outer peripheral side of the belt layer **104** can also be made substantially constant.

The invention claimed is:

1. A tire grinding method comprising:

when a tire to be retreaded is loaded to a holding mechanism of a grinding device and a tread portion of the tire to be retreaded that is rotated by the holding mechanism about a device axial center is to be grinded by grinding means,

detecting, with a metal detection sensor, along a rotating direction whose center is the device axial center, a distance from the device axial center to a metal belt layer of the tire to be retreaded that is held by the holding mechanism, and thereafter

causing the grinding means to relatively move with respect to the tire to be retreaded along a radial direction whose center is the device axial center on the basis of a position along a rotating direction of the tire to be retreaded and detected value of the distance from the device axial center to the belt layer, and grinding, with the grinding means, the tread portion of the tire to be retreaded that is rotated by the holding mechanism,

wherein when the tire to be retreaded is grinded by the grinding means, the grinding means is relatively moved along the radial direction, such that a distance from a center of curvature of the belt layer of the tire to be retreaded to the grinding means becomes constant, on the basis of the position along the rotating direction of the tire to be retreaded and the detected value of the distance from the device axial center to the belt layer that is detected by the metal detection sensor.

2. The tire grinding method of claim **1**, wherein before the distance from the device axial center to the metal belt layer of the tire to be retreaded that is held by the holding mechanism is detected by the metal detection sensor along the tire rotating direction, the tread portion is grinded until groove portions substantially disappear from a tread surface of the tire to be retreaded.

3. A tire grinding device comprising:

a holding mechanism that rotatably holds a tire to be retreaded about a device axial center and causes the tire to be retreaded to rotate about the device axial center;

grinding means that contacts a tread portion of the tire to be retreaded that is rotated by the holding mechanism and grinds the tread portion;

a metal detection sensor that detects, along a rotating direction whose center is the device axial center, a distance from the device axial center to a metal belt layer of the tire to be retreaded that is held by the holding mechanism; and

grinding position adjusting means that causes, when the tire to be retreaded is grinded by the grinding means, the grinding means to relatively move with respect to the tire to be retreaded along a radial direction whose center is the device axial center, on the basis of a position along a rotating direction of the tire to be retreaded and detected value of the distance from the device axial center to the belt layer,

wherein the grinding position adjusting means causes, when the tire to be retreaded is grinded by the grinding means, the grinding means to relatively move with respect to the tire to be retreaded along the radial direction, such that a distance from a center of curvature of the belt layer to the grinding means becomes constant, on the basis of the position along the rotating direction of the tire to be retreaded and the detected value of the distance from the device axial center to the belt layer that is detected by the metal detection sensor.

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